ANALYSIS OF THE APPLICATION OF TIME MANAGEMENT USING THE CPM METHOD IN THE REHABILITATION WORK PROJECT OF THE DISDIKBUDPORA HALL BUILDING

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ABSTRACT

Time management is one of the important factors in the successful implementation of construction projects because it is directly related to time efficiency, cost, and quality of work. In the Semarang Regency Disdikbudpora Hall Rehabilitation Project, the preparation of the implementation schedule is still not optimal due to the determination of the duration of work that has not considered the complexity and relationship between activities properly. This study aims to analyze the application of time management using the Critical Path Method (CPM) method to obtain a more effective project implementation duration and identify activities that are on the critical path. The research method used is a quantitative descriptive method by utilizing primary data in the form of field observations and secondary data in the form of time schedules, weekly reports, work drawings, and Cost Budget Plans (RAB). The analysis was carried out using the CPM method through forward pass, backward pass, and total float to determine the critical trajectory of the project. Data processing is done using Microsoft Excel and network visualization is created using AutoCAD.

The results showed that the normal duration of project completion based on the CPM method is 54 working days, 3 days faster than the existing implementation schedule of 57 calendar days. Activities included in the critical path include preparatory work, certain earthworks and foundations, concrete work, wall pairing, floor and wall coverings, and painting work. Activities on critical lines have a total float value of zero, so delays in the work will affect the overall duration of project completion. Based on the results of the analysis, the application of the Critical Path Method (CPM) has proven to be effective in optimizing project scheduling because it is able to identify critical activities and accelerate project completion time. This method can be used as a reference in controlling the implementation time of construction projects to be more efficient and planned.

Keywords: Critical Path Method, time management, critical path, project scheduling, construction project.

INTRODUCTION

State buildings are buildings for official purposes that are State property and are held with sources of financing derived from the State Budget and/or other legitimate acquisitions. State buildings such as government offices/offices as places used for government activities or activities and services to the community certainly have risks in the use of the building such as a decrease in the quality of the building. To carry out its functions optimally, the official office, especially the one reviewed, namely the Semarang Regency Education and Culture Office, needs to rehabilitate buildings on infrastructure that has experienced a decline in the quality of the building.

Scheduling is part of construction project planning, from scheduling there will be a description of the work, the duration of each activity, and the relationship between activities. In this regard, the successful implementation of a project on time is an important goal. With the knowledge of the project implementation period, the question often arises whether the project completion time is optimal or can the project completion time be accelerated.

In the Semarang Regency Disdikbudpora Hall Hall Project, the preparation of project scheduling occurs in determining the duration of the work without considering the type and complexity of the work, so that the resulting schedule becomes ineffective and unrealistic, so the right method is needed in optimizing the schedule of project activities. This study was conducted to analyze the application of time management using the CPM method in the rehabilitation work of the Semarang Regency Disdikbudpora hall building to be more efficient.

LITERATURE REVIEW

Previous studies have analyzed the application of time management with the CPM method in projects, such as research conducted by Syifa Nur Afiya, Ardana Sultan Alhaq, and Kusnadi (2023) resulting in the duration of project work obtained from the CPM method 28 days faster than the project scheduling time. CPM can estimate the time needed to carry out each activity and can determine the priorities of activities that must receive more supervision so that the activities can be completed as planned. The research is in line with the research conducted by Delli Noviarti Rachman and Iswendra (2018) where the scheduling of development plans using the CPM method can save time to 119 days, so that the CPM method is effective as a method of implementing time management.

Project Management

Project management is all the planning, implementation, control and coordination of a project from the beginning (idea) to the end of the project to ensure the implementation of the project on time, at the right cost and with the right quality. The purpose of applying project management in a development is to get the best technical method or method so that with limited resources maximum results can be obtained in terms of speed, savings, and comprehensive work safety. Activities in the project management process are planned in detail and accurately to reduce deviations so that the maximum end product is obtained. If there are correction actions in the next process, try not to make too many corrections.

Project Scheduling

Project scheduling is an activity that sets the duration of project activities that must be completed, raw materials, labor and time needed by each activity. The scheduling process begins with identifying project activities. Each activity is identified so that it can be easily monitored and can be understood to be implemented, so that the project objectives that have been determined can be carried out according to the schedule. There are 3 (three) methods in scheduling, namely: Planning,

Priorities, and Pacing. In making a schedule, it must have characteristics, namely clear, realistic, flexible, and continuous in accordance with the time planning function.

Critical Path Method (CPM)

CPM can estimate the time needed to carry out each activity and can determine the priorities of activities that must receive more supervision so that the activities can be completed as planned. In determining the estimated completion time, the term critical path will be known, which is a path that has a series of activities with the longest total time and the fastest project completion time. Therefore, it can be said that a critical path is a path that goes through critical activities from the beginning to the end of the path that has a great influence on the time of project completion, and in a work network can have several critical paths. In addition to this critical trajectory there are other trajectories that have a shorter duration than the critical trajectory. Thus, this non-critical trajectory has time to be late, which is called *a float*.

To analyze the network diagram the critical path has three characteristics:

a. The longest path in a process
b. A path with a grace period between the completion of one stage of an activity and the start of the next stage of the activity
c. The absence of such a grace period is the critical nature of the critical path.

The accumulated duration of the longest time in the critical path will be used as an estimate of the overall project completion time. Delays in critical activities will cause delays in the total project completion time. The requirements for the critical path are as follows:

a. In the first activity, ES (earliest activity start time) = LS (latest activity start time) = 0
b. In the last activity, LF (latest activity finish time) = EF (earliest activity finish time)
c. Total Float = 0

METHODS

This study uses a quantitative descriptive method to analyze the application of time management in the Rehabilitation Project of the Semarang Regency Disdikbudpora Hall Building using *the Critical Path Method* (CPM) method. A quantitative approach is used to calculate the duration of work, dependency relationships between activities, critical trajectories, and project completion time based on project scheduling data. For more details on the following research flow:

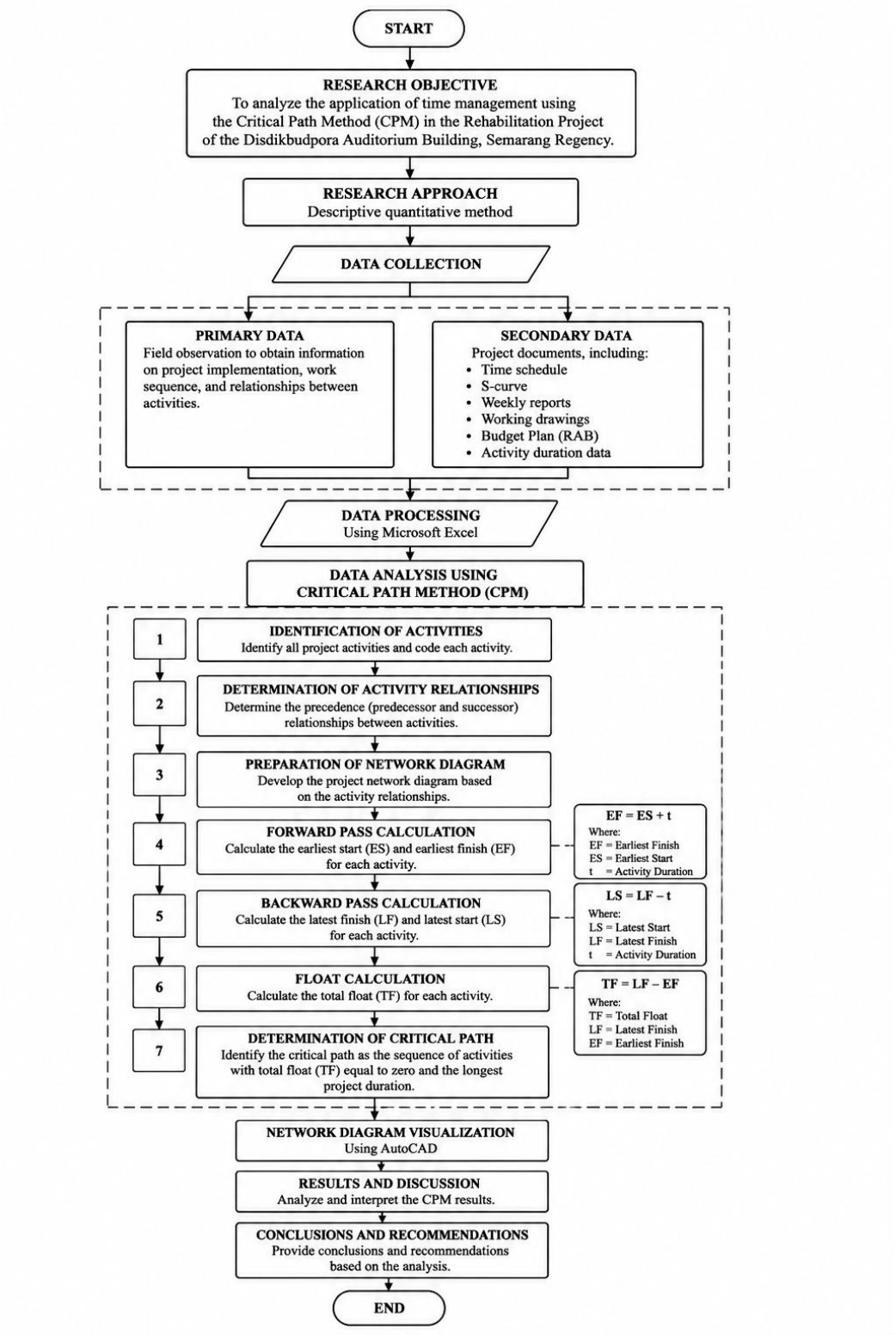

Figure 1. Research Flow

RESULTS AND DISCUSSION

This study was conducted to analyze the application of time management using CPM. The steps are as follows:

1. Normal Work Duration Analysis

Based on secondary data, the details of the work can be known, then a normal work duration analysis is carried out to obtain the duration of each work by calculating the coefficient and productivity of labor, the following is an example of the calculation of normal time duration analysis on earthworks and foundations:

The total duration of work required in earthworks and foundations in ordinary excavation is 1 day, with the following analysis:

Coeficin:

- Employees = 0.750
- Foreman = 0.025

The productivity produced by 3 workers and 1 foreman is as follows:

- Workers = number of people : coefficient = 3 : 0.750 = 4
- Foreman = number of people : coefficient = 1 : 0.025 = 40

With the productivity generated by labor, it is possible to obtain the duration carried out in ordinary soil excavation work as deep as 2.92 m3, namely by taking the maximum duration that can be done by the existing workforce, with the following calculations:

- Workers = volume : productivity = 2.92 : 4 = 0.730 ≈ 1 day
- Foreman = volume : productivity = 2.92 : 4= = 0.073 ≈ 1 day

From the calculation above, the maximum duration of each labor is 1 day, so the duration of ordinary soil excavation work deep of 2.92 m3 is 1 day. The calculation is carried out on all jobs, so that the normal duration of each job is obtained, which is then analyzed the relationship between one job and another.

2. Analysis of the Relationship Between Jobs

In creating a work network, identification of predecessor activities must be carried out. By making a relationship between jobs to find out the order of a series of jobs. An activity is likely to be preceded by several activities (more than one predecessor) several activities that follow it (successor). An analysis of the relationship between jobs can be seen in Table 1.

Table 1. Analysis of the Relationship Between Jobs

NO	URAIAN PEKERJAAN	Durasi (Hari)	Kode	Aktivitas Pendahulu
I	**PEKERJAAN PERSIAPAN**			
1	Papan Nama Kegiatan	1	A1	-
2	Pekerjaan Persiapan (Bongkaran, Pembersihan Lahan dan lain-lain)	1	A2	-
3	Biaya Penerapan Sistem Manajemen Keselamatan Konstruksi (SMKK)			
	1. Penyiapan dokumen penerapan SMKK			
	Pembuatan dokumen RKK, RMPK	1	A3	-
	2.Sosialisasi, Promosi dan Pelatihan			
	Papan Informasi Keselamatan Konstruksi	1	A4	-
	3.Alat Pelindung Kerja dan Alat Pelindung Diri			
	- Topi Pelindung (Safety Helmet)	1	A5	-
	- Pelindung pernafasan dan mulut (masker,masker respirator)	1	A6	-
	- Sepatu keselamatan (Safety Shoes, rubber safety shoes and toe cap)	1	A7	-
	- Rompi Keselamatan (Safety Vest)	1	A8	-
	4. Fasilitas sarana, prasarana, dan alat kesehatan			
	- Peralatan P3K	1	A9	-
A	**PEKERJAAN REHAB GEDUNG AULA A DIKNAS**			
I	**PEKERJAAN TANAH DAN PONDASI**			
1	Penggalian 1 m3 Tanah Biasa sedalam s.d. 1 m untuk volume s.d 200 m3	1	B1	A2
2	Pengurugan Kembali 1 m3 Galian Tanah	1	B2	B1
3	Pemasangan 1 m3 Pondasi Batu Belah	1	B3	B1
II	**PEKERJAAN BETON**			
1	Pembuatan 1 m3 Beton Mutu f'c = 14,5 Mpa (K175)	3	C1	C4
2	Penulangan 1 kg dengan Besi Polos atau Besi Sirip	2	C2	B2,B3
3	Pemasangan 1 m2 Bekisting untuk Sloof Beton Bangunan Gedung	2	C3	C2
4	(K3) Pemasangan 1 m2 Bekisting untuk Lantai Sistem Bondex	2	C4	D1
III	**PEKERJAAN BESI & ALLUMUNIUM**			
1	Pemasangan 1 kg Besi Profil untuk tangga gudang	8	D1	C2
2	Pemasangan 1 m2 Sunscreen Allumunium	2	D2	D3
3	Pemasangan 1 m Kusen Pintu dan Jendela Allumunium	2	D3	D1
4	Pemasangan 1 m2 Pintu dan Jendela Allumunium Strip Lebar 8 cm	1	D4	D3
5	Pemasangan Railing tangga	2	D5	I1
6	Pemasangan Pintu hollow (4x2, 4x4, 4x6)	8	D6	D2
IV	**PEKERJAAN PASANGAN DINDING**			
1	Pemasangan 1 m2 Dinding Bata Merah (5x11x22)cm Tebal 1/2 Batu Camp. 1SP : 6PP	1	E1	C1
3	Pemasangan 1 m2 Plesteran 1 Pc : 6 Pp Tebal 15 mm	9	E2	E1
4	Pemasangan 1 m2 Acian	6	E3	E2
V	**PEKERJAAN PENUTUP LANTAI DAN DINDING**			
1	Pemasangan 1m2 Lantai Keramik Ukuran 40x40cm Lantai Gudang	2	F1	F2
2	Pembongkaran dan Pemasangan Kembali 1m2 peredam dinding	7	F2	E3
3	Penyemprotan Anti Rayap	1	F3	F4
4	Pemasangan 1m2 Papan Multiplek 9mm untuk Partisi dinding	4	F4	E3
VI	**PEKERJAAN LANGIT LANGIT**			
3	Pemasangan 1m2 Langit-langit Papan Gypsum	1	G1	E2
VII	**PEKERJAAN PENUTUP ATAP**			
1	Pemasangan 1 m' Nok Atap Spandek Berpasir	1	H1	H2
2	Perbaikan 1 m2 Genteng Plentong /Genteng Beton	3	H2	G1
VIII	**PEKERJAAN KAYU**			
1	Pembuatan 1 m2 Trap Tangga Kayu Kelas I dan II Tebal 2cm	3	I1	C1
IX	**PEKERJAAN KUNCI DAN KACA**			
1	Pemasangan 1 buah Kunci Tanam Biasa	1	J1	D4
2	Pemasangan 1 buah Engsel Pintu	2	J2	J1
3	Pemasangan 1 Buah Kunci Slot (Grendel) untuk Jendela	1	J3	J1
4	Pemasangan 1 m2 Kaca Polos Tebal 5 mm	2	J4	J1
5	Pemasangan 1 m2 Kaca Tempered tb. 12 mm	1	J5	J4
6	Pasang Engsel Casement	1	J6	J3
7	Pasang Lever Handle pintu Aluminium	1	J7	J3
X	**PEKERJAAN PENGECATAN**			
1	Pengecatan 1 m2 Tembok Baru (1 Lapis Plamuur, 1 Lapis Cat Dasar, 2 Lapis Cat Penutup)	1	K1	F1
2	Pengecatan 1 m2 Tembok Lama (1 lapis Plamir, 2 lapis Cat Penutup)	5	K2	F1
3	Pengecatan 1 m2 Tembok Lama (1 lapis Plamir, 2 lapis Cat Penutup) Exterior	6	K3	K2
4	Pengecatan 1 m2 Permukaan Baja dengan Menie Besi (Zinc Chromate)	2	K4	K2
5	1 m2 Pengecatan Bidang Kayu Baru (1 Lapis Plamuur, 1 Lapis Cat Dasar, 2 Lapis Cat Penutup)	1	K5	K2
XI	**PEKERJAAN INSTALASI LISTRIK**			
1	Pemasangan Lampu Down LED 9 Watt	1	L1	L3
2	Pemasangan Lampu LED TL18 watt Philips	1	L2	L3
3	Instalasi Titik Lampu	1	L3	A2

(Source: Analysis Results)

3. Advanced Calculation Analysis

In the process of determining the project completion time, critical activities are determined to be optimized with CPM. Several calculations are needed, namely using a *forward pass* that starts at the starting point to the end to determine the *earliest start* (ES) and *earliest finish* (EF).

Example of forward *pass calculation*:

Finding the earliest finish time (EF/Earliest Finish) in ordinary soil excavation work (B1) is to determine the activity that precedes the ordinary soil excavation work (B1), namely A2, where the period of A2 activity is 1 day, then obtained:

EF (i-j) = ES (i-j) + t (i-j)

= 1 + 1 = 2.

In the excavation work (B2), the preceding activity is B1, where the period of work B1 is 2 days, so it is obtained:

EF (i-j) = ES (i-j) + t (i-j)

= 2 + 1 = 3.

The calculation was carried out on the entire list of job descriptions, and the results of the calculation analysis obtained that the normal duration of project completion was 54 working days.

4. Countdown Analysis

The *backward pass* calculation starts at the end point to the start point to determine *the latest start* (LS) and latest finish (LF). Example of *backward pass calculation* :

Find the latest time (LS/ Latest Start) on the exterior old wall painting work (K3) with the formula:

LS (i-j) = LF (i-j) – t

= 54 – 6 = 48

Find the latest time (LS / Latest Start) on the old wall painting job (K2) with the formula:

LS (i-j) = LF (i-j) – t

= 48 – 5 = 43

5. Total Time Calculation Analysis (Float)

Calculating *forward passes* and *backward passes* is carried out to obtain a float value, which functions to know which activities have excess time or the difference in the duration of time used, so that if there is a delay in one of these works, the project will not experience delays. An activity can be categorized as being on a critical path if it has a float value = 0.

An example of a total float calculation on a typical excavation job:

TF = LF – EF

= 2 – 2 = 0

Calculations are carried out for all work, the results of forward, backward, and float calculations are seen in Table 2.

Table 2. Forward Calculation, Countdown, and Float Results

NO	URAIAN PEKERJAAN	Kode	Durasi (Hari)	Paling Awal		Paling Akhir		Total Float (TF)
				Mulai (ES)	Selesai (EF)	Mulai (LS)	Selesai (LF)	
VIII	**PEKERJAAN KAYU**							
1	Pembuatan 1 m2 Trap Tangga Kayu Kelas I dan II Tebal 2cm	I1	3	18	21	23	26	5
IX	**PEKERJAAN KUNCI DAN KACA**							
1	Pemasangan 1 buah Kunci Tanam Biasa	J1	1	16	17	24	25	8
2	Pemasangan 1 buah Engsel Pintu	J2	2	17	19	26	28	9
3	Pemasangan 1 Buah Kunci Slot (Grendel) untuk Jendela	J3	1	17	18	26	27	9
4	Pemasangan 1 m2 Kaca Polos Tebal 5 mm	J4	2	17	19	25	27	8
5	Pemasangan 1 m2 Kaca Tempered tb. 12 mm	J5	1	19	20	27	28	8
6	Pasang Engsel Casement	J6	1	18	19	27	28	9
7	Pasang Lever Handle pintu Aluminium	J7	1	18	19	27	28	9
X	**PEKERJAAN PENGECATAN**							
1	Pengecatan 1 m2 Tembok Baru (1 Lapis Plamuur, 1 Lapis Cat Dasar, 2 Lapis Cat Penutup)	K1	1	43	44	53	54	10
2	Pengecatan 1 m2 Tembok Lama (1 lapis Plamir, 2 lapis Cat Penutup)	K2	5	43	48	43	48	0
3	Pengecatan 1 m2 Tembok Lama (1 lapis Plamir, 2 lapis Cat Penutup) Exterior	K3	6	48	54	48	54	0
4	Pengecatan 1 m2 Permukaan Baja dengan Menie Besi (Zinc Chromate)	K4	2	48	50	52	54	4
5	1 m2 Pengecatan Bidang Kayu Baru (1 Lapis Plamuur, 1 Lapis Cat Dasar, 2 Lapis Cat Penutup)	K5	1	48	49	53	54	5
XI	**PEKERJAAN INSTALASI LISTRIK**							
1	Pemasangan Lampu Down LED 9 Watt	L1	1	2	3	4	5	2
2	Pemasangan Lampu LED TL18 watt Philips	L2	1	2	3	4	5	2
3	Instalasi Titik Lampu	L3	1	1	2	4	5	3

NO	URAIAN PEKERJAAN	Kode	Durasi (Hari)	Paling Awal		Paling Akhir		Total Float (TF)
				Mulai (ES)	Selesai (EF)	Mulai (LS)	Selesai (LF)	
I	**PEKERJAAN PERSIAPAN**							
1	Papan Nama Kegiatan	A1	1	0	1	1	2	1
2	Pekerjaan Persiapan (Bongkaran, Pembersihan Lahan dan lain-lain)	A2	1	0	1	0	1	0
3	Biaya Penerapan Sistem Manajemen Keselamatan Konstruksi (SMKK)							
	1. Penyiapan dokumen penerapan SMKK							
	Pembuatan dokumen RKK, RMPK	A3	1	0	1	1	2	1
	2.Sosialisasi, Promosi dan Pelatihan							
	Papan Informasi Keselamatan Konstruksi	A4	1	0	1	1	2	1
	3.Alat Pelindung Kerja dan Alat Pelindung Diri							
	- Topi Pelindung (Safety Helmet)	A5	1	0	1	1	2	1
	- Pelindung pernafasan dan mulut (masker,masker respirator)	A6	1	0	1	1	2	1
	- Sepatu keselamatan (Safety Shoes, rubber safety shoes and toe cap)	A7	1	0	1	1	2	1
	- Rompi Keselamatan (Safety Vest)	A8	1	0	1	1	2	1
	4. Fasilitas sarana, prasarana, dan alat kesehatan							
	- Peralatan P3K	A9	1	0	1	1	2	1
A	**PEKERJAAN REHAB GEDUNG AULA A DIKNAS**							
I	**PEKERJAAN TANAH DAN PONDASI**							
1	Penggalian 1 m3 Tanah Biasa sedalam s.d. 1 m untuk volume s.d 200 m3	B1	1	1	2	1	2	0
2	Pengurugan Kembali 1 m3 Galian Tanah	B2	1	2	3	4	5	2
3	Pemasangan 1 m3 Pondasi Batu Belah	B3	1	2	3	2	3	0
II	**PEKERJAAN BETON**							
1	Pembuatan 1 m3 Beton Mutu f'c = 14,5 Mpa (K175)	C1	3	15	18	15	18	0
2	Penulangan 1 kg dengan Besi Polos atau Besi Sirip	C2	2	3	5	3	5	0
3	Pemasangan 1 m2 Bekisting untuk Sloof Beton Bangunan Gedung	C3	2	5	7	13	15	8
4	(K3) Pemasangan 1 m2 Bekisting untuk Lantai Sistem Bondex	C4	2	13	15	13	15	0
III	**PEKERJAAN BESI & ALLUMUNIUM**							
1	Pemasangan 1 kg Besi Profil untuk tangga gudang	D1	8	5	13	5	13	0
2	Pemasangan 1 m2 Sunscreen Allumunium	D2	2	15	17	18	20	3
3	Pemasangan 1 m Kusen Pintu dan Jendela Allumunium	D3	2	13	15	16	18	3
4	Pemasangan 1 m2 Pintu dan Jendela Allumunium Strip Lebar 8 cm	D4	1	15	16	23	24	8
5	Pemasangan Railing tangga	D5	2	21	23	26	28	5
6	Pemasangan Pintu hollow (4x2, 4x4, 4x6)	D6	8	17	25	20	28	3
IV	**PEKERJAAN PASANGAN DINDING**							
1	Pemasangan 1 m2 Dinding Bata Merah (5x11x22)cm Tebal 1/2 Batu Camp. 1SP : 6PP	E1	1	18	19	18	19	0
3	Pemasangan 1 m2 Plesteran 1 Pc : 6 Pp Tebal 15 mm	E2	9	19	28	19	28	0
4	Pemasangan 1 m2 Acian	E3	6	28	34	28	34	0
V	**PEKERJAAN PENUTUP LANTAI DAN DINDING**							
1	Pemasangan 1m2 Lantai Keramik Ukuran 40x40cm Lantai Gudang	F1	2	41	43	41	43	0
2	Pembongkaran dan Pemasangan Kembali 1m2 peredam dinding	F2	7	34	41	34	41	0
3	Penyemprotan Anti Rayap	F3	1	38	39	40	41	2
4	Pemasangan 1m2 Papan Multiplek 9mm untuk Partisi dinding	F4	4	34	38	36	40	2
VI	**PEKERJAAN LANGIT LANGIT**							
3	Pemasangan 1m2 Langit-langit Papan Gypsum	G1	1	28	29	36	37	8
VII	**PEKERJAAN PENUTUP ATAP**							
1	Pemasangan 1 m' Nok Atap Spandek Berpasir	H1	1	32	33	40	41	8
2	Perbaikan 1 m2 Genteng Plentong /Genteng Beton	H2	3	29	32	37	40	8

Description:

= Critical Activities

(Source: Analysis Results)

The results of the calculation analysis above are then depicted in the CPM network diagram which can be seen in Figure 2.

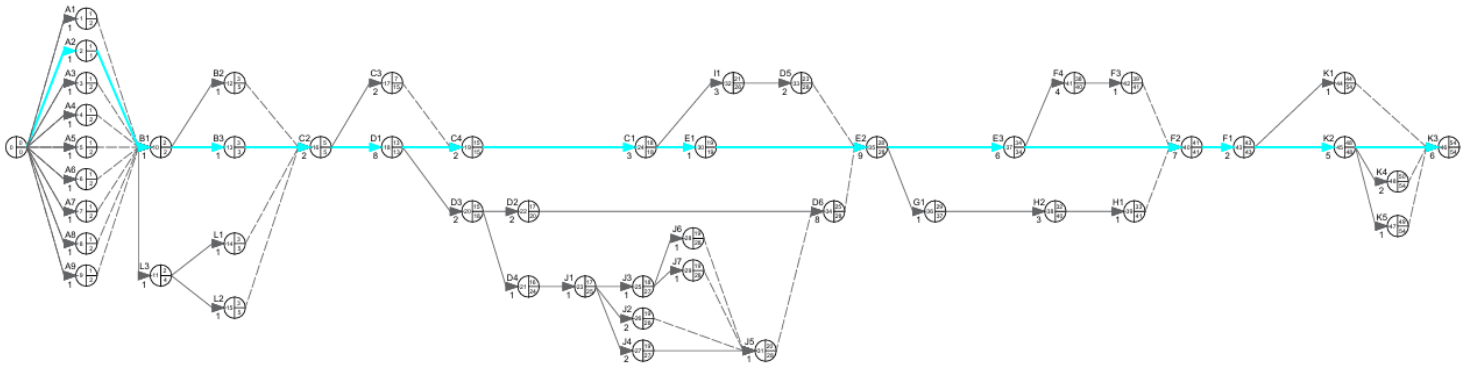

Figure 2. Normal Duration Network CPM Chart

(Source: Analysis Results)

CONCLUSION

Based on the results of the analysis of the application *of the Critical Path Method* (CPM) in the Rehabilitation Project of the Disdikbudpora Hall Building, Semarang Regency, it can be concluded that the CPM method is able to be used effectively to analyze and control the implementation time of construction projects. The results of the analysis showed that the duration of project completion using the CPM method was 54 working days, faster than the existing implementation schedule of 57 calendar days, resulting in a time efficiency of 3 days. Activities that fall under the critical path have a *total float* value of zero, so delays in those activities will directly affect the overall project completion time. Some of the works that are on the critical track include preparatory work, certain structure work, wall pairing work, floor and wall covering work, and painting work.

The application of the CPM method provides benefits in determining the order of priority of work, identifying critical activities, and helping to control project time so that the execution of work becomes more planned and efficient. In addition, the CPM method can be used as a reference in project management decision-making to minimize the risk of construction work delays. Based on the results of the study, it is recommended that contractors and project implementers apply the CPM method more optimally at the planning and control stages of construction projects to improve the efficiency of project implementation time and the overall quality of project management.

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